Internet Of Things(IoT) approach in solving Medication Errors

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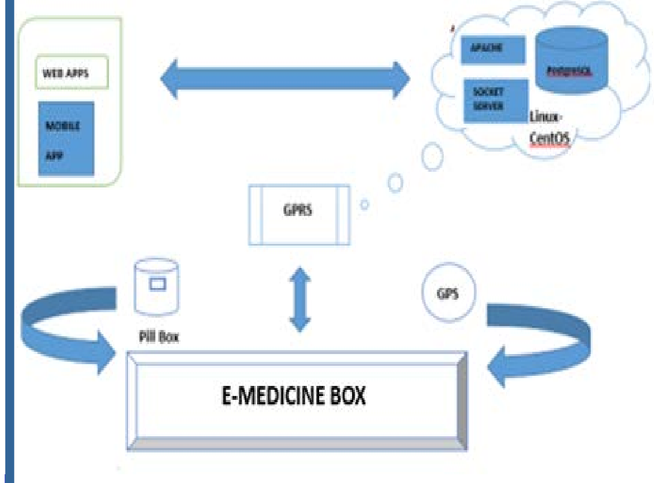
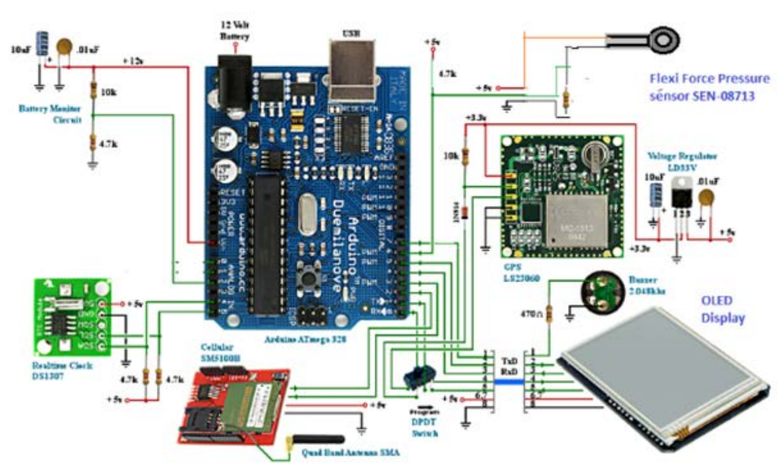
ABSTRACT:

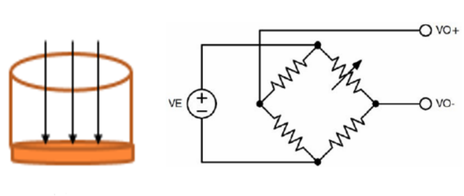
Approximately each year 1.3 million people in the United States are affected due to "medication errors". In a study by the FDA that collected and evaluated the reports of medication errors found that the basic error regarding medications was related to administration of an improper dose of medicine, accounting for 41% of fatal medication errors. Giving the wrong drug and using the wrong channel of administration each accounted for 16% of the errors. Almost half of the fatal medication errors occurred in people over the age of 60. Older people may be at greatest risk for medication errors because they often take multiple prescription medications. To address this issue we are proposing an electronic medicine box each equipped with an intelligent base and round the clock cloud connectivity. The dosage details about medication is taken care by the cloud, which can be accessed, configured and maintained by the patient or by an authorized user. This project is an Embedded Web Application inspired by the emerging concept of Internet Of Things (IOT). Along with an OLED display, a built-alarm installed in e-medicine box is used to indicate the time for medication. Dosage times are pre-recorded in the cloud by the user through the web portal. Whenever there is any abnormality observed in these recordings automated alerts (SMS or email) are sent to a family member or doctor via the mail and SMS servers in the cloud. Additionally, in this design we are proposing an in-built GPS module to track the location of patients in case of emergencies.



Block diagram of E-medicine Box



Circuit diagram of E-medicine Box hardware unit.



Circuit arrangement at the surface of E-medicine box

Web Dashboard for User Interface

FUNDAMENTAL OBJECTIVES:

- Calculating the quantity of pills in the compartment using flexi force pressure sensor.
- Secure communication between the hardware device and the linux CentOS server using GPRS SIM5218 through HTTPS communication protocol.
- Real time location tracking of patient during emergencies via GPS.
- Alert the patient about shortage of medicine dosage.
- Reminds the patient for medicine intake at prescribed time.
- Prohibits the patient from multi dosage.
- Hardware device built around Arduino board using Atmega328p microcontroller is powered by 7.4V lithium iron phosphate battery.
- Alarm, mobile and e-mail alerts can be set through web dashboard.
- Web interface to track the medicine dosage graphically build by implementing Java spring technology.
- Access to an authorized user or a family member to send custom alerts to patients mobile.
- Secure data storage using PostgreSQL in the cloud.
- Separate portal for doctors to track the medication history of patients.
- Doctors can regularly update the medicine prescription and an alert will be received by the prescribed users.

DESIGN AND IMPLEMENTATION:

The e-medicine box is based on the Arduino board using ATmega328P microcontroller having 14 input or output pins, EEPROM 1KB, SRAM of size 2KB and having a clock speed of 16MHz. The board is programmed using Arduino IDP, an integrated development platform (IDP) for developing and debugging Atmel microcontroller. The device is powered up using 7.4v-1500mah Lithium iron phosphate battery, at the time of boot up the device runs through a boot loader circuit to identify whether all the modules are getting enough power supply and are connected properly. This e-medicine box uses flexi force pressure sensor at its surface which acts as a variable resistor in a Wheatstone bridge circuit. Wire when placed under tension changes its resistance, so in strain gauges wire is arranged in such a way that it will maximize the effect. These are etched foil patterns which are glued together to a material which is sensitive to tension such as metal bar. Whenever there is a change observed in the resistance of the value this may indicate that the tablets have been added to the box or removed based on high or low resistance. The principle of wheat stone bridge is to know value of resistance in a circuit when other three resistance value is known and the current in cross branch is zero. When tension is felt on the base or the wires change in resistance is generated and this signal is fed to a differential amplifier from the wheat stone bridge for amplification. Then to the ADC pin of the microcontroller to convert analog signal to digital bits for further calculations. Calibration of e-medicine box can be done by calibrating offset error and gain error. To set the offset error, calculate the voltage generated when the sensors parameter is zero or when there is no tablet in the e-medicine box and record the offset value in EEPROM when there is no weight in the box. Similarly gain calibration is also done using predefined weight as reference. Before using the e-medicine box needs to be configured to absolute weight of all the pills in the compartment by the user which is needed to calculate the change in weight of pills. So while using it for the first time add the pills and press the button near the compartment to indicate as filled. This value will be recorded to calculate the change on number of pills. Patient or any other family member enters the medication information in the dashboard according to compartment in which they are storing medicine. Medicines are loaded in the compartments of smart pill box according to the doctor's prescriptions. For example compartment 1 is for morning, compartment 2 is for noon, and compartment 3 is for evening dosage. The medicines which are stored in the box should be same as entered in web dashboard under compartment 1 information or compartment 2 information. After the medicine box is fully loaded close the lid of the box and hold the button on the compartment for 5 seconds to indicate the optimum weight for that dosage. While on travel and in case of emergency if patient needs immediate access of any medicine or need help he/she can simply press alert button on the e-medicine box which will send complete information of medicines in the box along with the location of patient to family members and doctor in form of SMS and email. If there is any medicine missing it is highlighted in the SMS or email sent. Software involves a CentOS server, PostgreSQL and a web dashboard for patients, family members and doctor or nurse. The dashboard edit, read, write permissions vary depending upon the user role who is logging into the website. The dashboard has multiple tabs in it such as live tracking, statistics of patient's medical history, doctor's prescription, pending dosage, dosage taken, custom emailing and SMS functionality, information about pills with reminder time, etc

CONCLUSION:

The advancement and low cost of wireless communication have given the opportunity to innovate and contribute to health care systems as it provides portability, ease of deployment/scalability, real time, reconfiguration and self-organization. By implementing the concepts of Internet Of Things(IoT) this project is a small step for betterment of our society which helps to avoid medication errors by helping patients maintain their medicine dosage and reducing the apprehension of family members. Future scope for this project is endless as we can later integrate sensors to record the vital information of patients body such as heartbeat, temperature, oxygen levels,etc. and by implementing sophisticated techniques we can also diagnose muscular and neurological disorders. . This can be an efficient solution to decrease the gap created by the unavailability of highly qualified doctors or experts in the field of medicine in remote areas, and even in cities of some developing countries.